(12) UK Patent Application (19) GB (11) 2 379 624 (13) A

(43) Date of A Publication 19.03.2003

(21) Application No 0122515.0

(22) Date of Filing 18.09.2001

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(51) INT CL[7]
A47J 31/46

(52) UK CL (Edition V)
B2F FED

(56) Documents Cited
GB 2121762 A
EP 0801922 A1
FR 002513106 A

(58) Field of Search
UK CL (Edition T) A4E, B2F
INT CL[7] A47J, B65D
Other: ONLINE: WPI, JAPIO, EPODOC

(54) Abstract Title
Beverage making apparatus

(57) A method of foaming a beverage injects a high pressure liquid into a receptacle 17 containing a foamable substance 19. The nozzle (20, fig 1) for doing this is tapered such that the bore gradually decreases from the inlet (22, fig 1) to the outlet (24, fig 1). The outlet has a cross-sectional area of 0.2-5 mm^2. Preferably, the apparatus also includes another nozzle for spraying a small amount of liquid onto the foamed beverage to remove any over sized bubbles at the surface. The apparatus preferably further includes a means for supplying a capsule (1, fig 2) of the dehydrated beverage to a point where hot water can be injected into the capsule to brew the beverage and a release means to allow the brewed beverage to flow into the said receptacle and a second capsule for the foaming agent which is then operated on as the first capsule. The capsule is constructed such that the bottom thereof is sealed by an adhesive (8, fig 3) which melts under the heat of the inserted hot water.

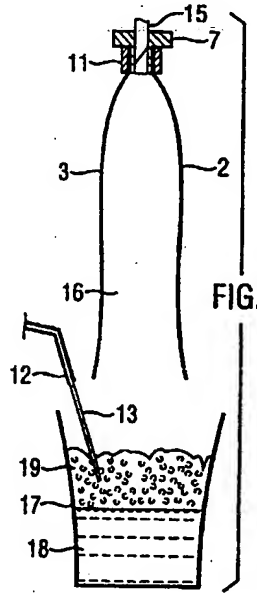

FIG. 4

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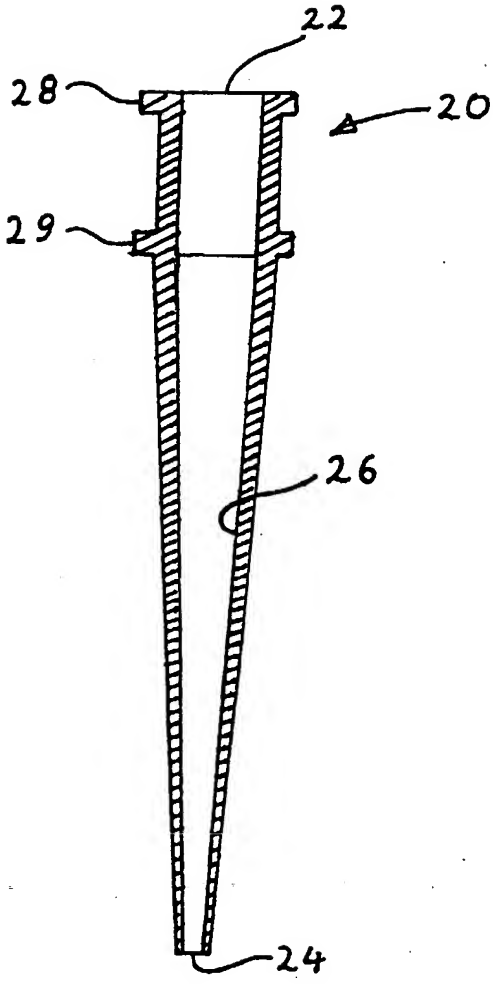


FIG. 1

FIG. 2

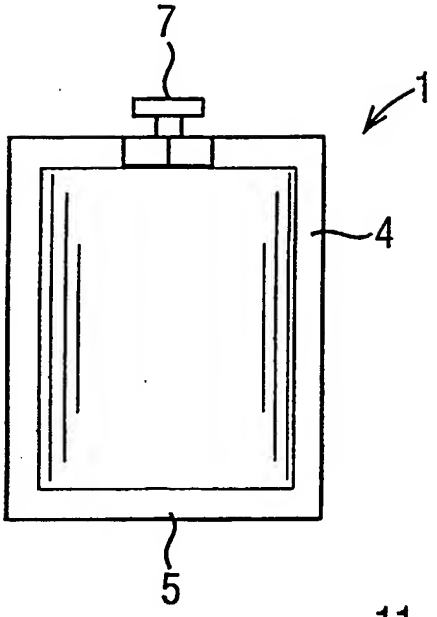
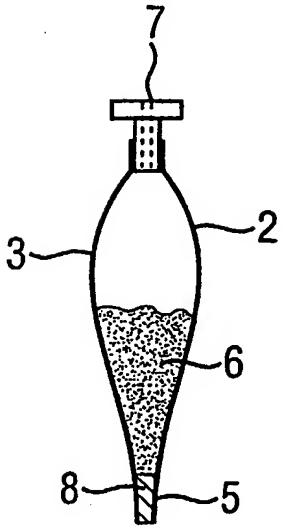


FIG. 3



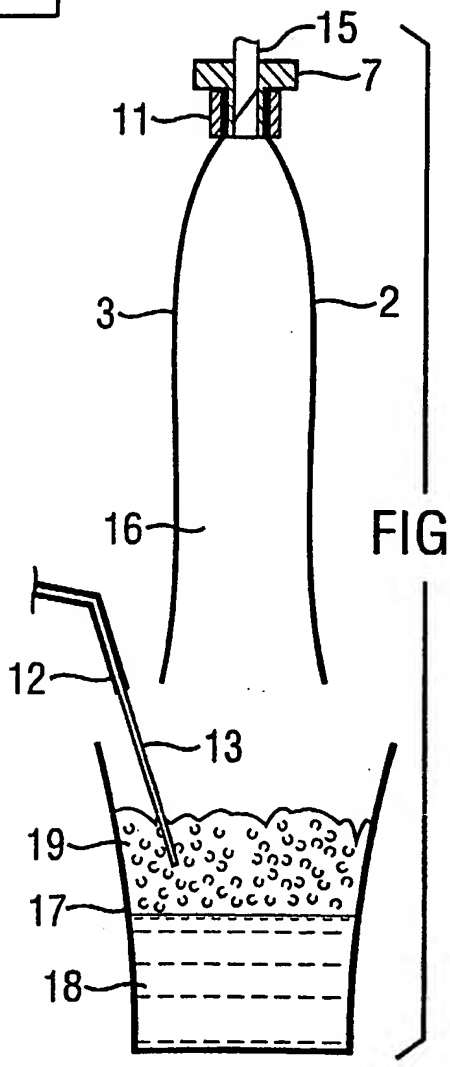


FIG. 4

BEVERAGE MAKING APPARATUS AND METHOD

The present invention relates to methods of production of beverages, and in particular to the production of foamed drinks such as milk shakes, cappuccino coffee and frothy hot chocolate.

It is known to form edible foams from fresh cold milk by high-shear mixing, for example in the preparation of milk shakes. It is also known to serve coffee and other hot beverages with a layer of hot milk foam over the liquid beverage. The hot milk foam is traditionally made by injecting steam under pressure through a hollow steam wand into cold fresh milk to heat and foam the milk. The milk foam is then poured onto liquid coffee to form the beverage, for example cappuccino or latte.

The milk foaming is normally carried out separately from the coffee brewing, because the essential oils present in coffee have a deleterious effect on foaming.

The traditional method of forming hot milk foam for cappuccino or latte does not lend itself to use in beverage vending installations. This is in part because fresh or liquid milk is difficult to handle in such installations. Furthermore, most vending installations are not equipped to supply steam under pressure. In addition, the use of a steam wand immersed in the liquid milk could present cross-contamination problems.

It is known to provide a powdered beverage whitener containing encapsulated nitrogen gas that produces a foam when it is dispersed in coffee. However, the foam does not have the same bulk and stiffness (spoonability) as a conventional cappuccino foam.

It is also known to produce a foam in a vending machine by depositing a powdered milk into a cup, followed by jetting hot water into the cup to dissolve the powdered milk and foam the milk by the action of high shear between the water jet and the milk. This suffers from the reduced consumer acceptability and mess associated

with depositing a powdered milk into the cup. Furthermore, the milk powder may not dissolve completely. In order to achieve more complete dissolution of the powder it is necessary to move the jet relative to the cup by means of an X-Y table or similar equipment, thereby increasing the cost of the apparatus. Furthermore, the water jet must be formed by forcing water through a narrow orifice which is prone to blockage by particles or by limescale deposition.

US patent 2,977,231 describes pressurised packages containing liquid concentrates, especially for the production of milkshakes. The packages have a discharge orifice of diameter about 1.3 to 2.4 mm (0.05 inch to 0.09 inch) and are pressurized to about 500kPa (75 pounds). The resulting narrow, high speed jets achieve effective mixing and foaming through shear forces when injected into water.

US patent 3,622,354 describes packages similar to those of US 2,997,231, but with the viscosity of the liquid concentrate in the package controlled so as to enable satisfactory mixing and foaming to be achieved with a nozzle diameter of about 3 mm. This enables the package to be dispensed more quickly.

EP-A-0885154 describes a dispensing device for the preparation of a foamy beverage. The device contains a milk concentrate and is pressurised to 900-1000 kPa (9-10 bar) with an orifice diameter of at most 1 mm. The resulting very high speed jet of the concentrate gives effective mixing and foaming of the concentrate when it is injected into a liquid beverage.

In a first aspect, the present invention provides a beverage making apparatus, wherein the apparatus comprises a liquid injection nozzle having an inlet and an outlet and a bore extending between the inlet and the outlet, wherein the cross-sectional area of the outlet is from about 0.2 to about 5 mm^2, and wherein the bore is tapered between the inlet to the outlet.

The small cross-section of the outlet results in a narrow, high-velocity jet of liquid issuing from the outlet. This jet produces a foam by high-shear mixing of air and

liquid when it hits the surface of a liquid in a receptacle. The present invention avoids the problems of blockage and scale formation in the nozzle by providing a nozzle with a tapered bore. In particular, the nozzle is normally tapered in the vicinity of the outlet. Preferably, the bore is substantially continuously tapered between the inlet of the nozzle and the outlet of the nozzle.

The internal cross sectional area of the jet-forming outlet is generally from about 0.2 to about 3 mm^2, preferably from about 0.4 to about 2 mm^2, for example about 1 mm^2. Since water is substantially incompressible and not significantly viscoelastic, it follows that a circular water jet is produced having a diameter of from about 0.5 to about 2 mm, preferably from about 0.7 to about 1.5 mm.

The problems of scale deposition and blockage are further reduced by making the inner surfaces of the bore substantially smooth. That is to say, the inner surfaces of the bore preferably do not have steps or features thereon of height greater than 10 micrometers, and more preferably the inner surfaces of the bore do not have steps or features thereon of height greater than 1 micrometer. The surface roughness of the bore expressed as the root mean square deviation of the surface from the mean is preferably less than 5 micrometers, more preferably less than 1 micrometer. Preferably the RA number as determined by BS 1134-1961 or ASA B46.1-1962 is not worse than 1.6 micrometers, preferably in the range 0.1 to 0.4 micrometers.

The cross-section of the bore preferably does not include any angles that could nucleate scale deposition. Preferably, the cross-section of the bore is substantially circular.

The angle of taper of the nozzle bore is preferably small, so as to reduce turbulence of the liquid in the bore and that a jet, rather than a spray, emerges from the outlet. The taper angle may vary somewhat along the length of the bore. Preferably, the angle of taper of the bore is in the range of from about 0° to about 10°, and more preferably it is from about 0.5° to about 5°, at least in the vicinity of the outlet.

Preferably, the length of the bore is in the range of from about 1cm to about 10cm, more preferably from about 2 cm to about 6 cm. The nozzle is preferably formed in one piece by injection molding of a thermoplastic. Preferably, the nozzle is demountably fitted to the beverage making apparatus to permit replacement or cleaning of the nozzle.

The beverage making apparatus according to the present invention preferably further comprises a source of pressurised liquid connected to the inlet of the nozzle. In some embodiments for the production of milk shakes this will be a source of pressurized milk. In certain embodiments for the production of espresso-style coffee this will be a source of fresh-brewed coffee. In certain embodiments for the production of hot milk foams this will be a source of hot water. The source normally comprises a reservoir and a pump, such as a peristaltic, piston or diaphragm pump. The source is typically adapted to supply the liquid at pressures of from about 0.3 bar to about 2 bar gauge, at flow rates of from about 4 to about 40 ml/sec, preferably from about 6 to about 18 ml/sec per nozzle. The beverage making apparatus according to the present invention may comprise one, or more than one of the nozzles according to the invention in order to permit faster total liquid flow rates and foam formation.

Preferably, the apparatus according to the present invention further comprises a filter to remove solid particles from the water passing through the nozzle. Preferably, the filter is of the in-line strainer type. Preferably, the filter has a mesh size in the range of about 500 to about 1000 micrometers, which is less than the bore diameter it is protecting. The filter removes particles that could nucleate scale formation in the nozzle and protects the rest of the upstream supply system from damage.

The liquid supply line to the nozzle may be provided with a pressure sensor adapted to detect when the back pressure exceeds a predetermined level indicative of a blockage in the nozzle, for example a blockage due to scale

formation. This can indicate to the operator that the nozzle needs cleaning or replacing.

Preferably, the apparatus according to the present invention comprises an air pump, whereby the air produced by the pump is used to expel residual liquid from the nozzle line or the capsule injection line near the end of the brewing cycle to ensure no drips and a consistent drink volume. The air pump may be the same or different from the liquid pump.

In a second aspect, the present invention provides a process for the preparation of a beverage, wherein the process comprises the step of injecting a jet of liquid into a receptacle from a nozzle having an inlet and an outlet and a bore extending between the inlet and the outlet, wherein the cross-sectional area of the outlet is from about 0.2 to about 5 mm^2, and wherein the bore is tapered between the inlet to the outlet.

The nozzle normally forms part of a beverage making apparatus in accordance with the first aspect of the invention.

Preferably, the jet velocity of the liquid jet is from about 5 to about 50 m/s, more preferably from about 10 to about 25 m/s. The diameter of the jet is from about 0.5 to about 2 mm, preferably about 1 mm.

Typically the liquid is supplied to the nozzle at a pressure of from about 30 kPa (0.3 bar) to about 200 kPa (2 bar). The flow rate per nozzle is preferably from about 4 to about 40 ml/sec, preferably from about 6 to about 18 ml/sec. A plurality of jets may be provided to speed up the rate of liquid addition and foam formation. Preferably, at least one liquid jet is inclined at an angle to the vertical in order to achieve swirling of the liquid in the receptacle. Preferably, the total amount of liquid jetted into the receptacle is from about 30 to about 150 ml, more preferably from about 50 to about 100 ml.

The receptacle is typically a cup, for example a polystyrene cup. Typically, the bottom of the receptacle is located from 5 to 25cm below the outlet of the capsule.

It is occasionally found that the method described above produces a foam having undesirable large bubbles near the top. In such cases the method preferably further comprises the step of applying a water spray to the top of the foam in the receptacle after the step of water injection. The water spray disperses the larger bubbles. Typically the water spray is applied for 1 to 5 seconds and has a small droplet size.

It will be appreciated that the method of the invention may be applied to the production of milk shakes by injecting a milky liquid through the nozzle. It will also be appreciated that the method can be applied to the production of coffee having an espresso-style "crema" on the surface thereof by injecting a brewed coffee through the nozzle. However, the widest usefulness of the method according to the present invention is expected to be in the production of hot edible foams, in particular hot milk foams, in beverage dispensing installations by injecting hot water into a receptacle containing a foamable food ingredient.

Accordingly, in certain embodiments of the methods according to the present invention, the receptacle contains a foamable food ingredient and the liquid injected through the nozzle consists essentially of water.

The foamable ingredient is any food-acceptable substance that will form a foam on high shear mixing with water. The foamable ingredient is usually at least partially dehydrated for ease of handling and maximum storage stability. Typically the foamable ingredient comprises a partially or completely dehydrated dairy or non-dairy beverage whitened such as milk. Preferably, the foamable ingredient consists essentially of a foamable dairy or non-dairy milk concentrate, for example a granulated dried milk or a spray dried milk powder, optionally fat reduced. In certain embodiments the ingredient comprises an instantised milk granulate. Various milk powders are suitable, and the fat content and other characteristics of the milk powder can be optimised for each case. The milk powder may form part

of a hot chocolate drink or other beverage. In other embodiments the foamable ingredient may comprise chocolate or another beverage ingredient such as coffee.

The dry weight of the foamable ingredient may be from about 1 to about 50g, preferably from about 5 to about 15g. In other words, the amount of the ingredient in the receptacle is preferably sufficient for one portion of a foamed product, e.g. one cup of a foamy beverage.

In certain preferred embodiments, the method according to the present invention comprises the steps of: providing a capsule containing a foamable ingredient and having an outlet for allowing fluid to escape from the capsule; positioning the receptacle to collect fluid escaping from the capsule through the outlet; injecting aqueous liquid into the capsule to mix with the foamable ingredient; allowing the foamable ingredient mixed with the aqueous liquid to escape through the outlet into the receptacle; followed by injecting a jet of further aqueous liquid into the receptacle through a the nozzle to produce a foamed liquid in the receptacle.

The capsule is normally disposable after one use. The capsule may comprise at least one side formed from a substantially rigid sheet material. For example, capsules having substantially cylindrical or truncated conical shapes are envisaged. More typically the capsule comprises a body formed at least in part from flexible film material, for example a tubular sachet formed on a form-fill-seal machine, or a body formed by bonding together front and back sheets of film material around the edges thereof to define a sachet. The capsule will normally be substantially air and moisture impermeable before use in order to preserve the food ingredient in a shelf stable condition. Preferably, the package is substantially shelf stable. That is to say, it may be stored at ambient temperature and atmospheric conditions for a period of at least 3 months, preferably at least one year, without significant deterioration of the contents.

In certain embodiments the internal volume of the capsule is from about 25 to about 100 cm^3. The internal volume refers to the maximum volume of the capsule when any flexible parts are fully distended. This internal volume is typically at

least twice the volume of the foamable ingredient, in order to allow space for turbulent flow and mixing of the aqueous liquid with the ingredient in the capsule.

The capsule itself may be provided with a capsule inlet nozzle, for example as described in EP-A-0179641 or WO-A-9905036. In certain embodiments the method may comprise injecting liquid into two or more inlets in the capsule in order to improve mixing with the foamable ingredient. The two or more inlets may be connected through a manifold to a single liquid inlet duct. At least one of the inlets may be angled to assist turbulent mixing and washing out of the capsule.

The method according to this embodiment of the the invention initially operates by enabling, first, turbulent mixing of the liquid and the foamable ingredient in the capsule, followed by deposition of the resulting mixture into the receptacle and jetting liquid into the mixture in the receptacle to provide foaming. The use of a capsule removes earlier problems with direct deposition of solids into a receptacle and provides a better quality foam in larger quantities.

In certain embodiments the outlet of the capsule is sealed by a freshness barrier. The term "freshness barrier" refers to a barrier that is substantially impermeable to air or moisture so as to preserve the freshness of the foamable ingredient by preventing ingress of air or moisture through the liquid guide before brewing commences. The freshness barrier may be released by an external mechanical force or thermal field applied during brewing. The freshness barrier is preferably releasable by the action of pressure and/or hot water from inside the capsule during brewing. For example, the freshness barrier may comprise a layer of a sealant that is released by the action of heat and/or moisture, such as an adhesive as described in EP-A-0179641 or WO99/05036.

For example, in certain embodiments the capsule comprises two flexible sheets bonded together along a seam situated opposite the inlet, said bonding being releasable by the action of heat or pressure inside the capsule, whereby the two sheets peel apart under said action to provide said opening.

Preferably, where the outlet is sealed by a freshness barrier as hereinbefore described, the injection of liquid into the capsule initially causes mixing with the foamable food ingredient. The freshness barrier is then released to form said opening, thereby releasing the food ingredient into the receptacle.

Preferably, the aqueous liquid consists essentially of water, optionally mixed with steam. In certain embodiments the liquid is injected into the capsule at a pressure of from about 30 kPa (0.3 bar) to about 200kPa (2 bar). These pressures are suitable for use in vending equipment without special measures.

In certain embodiments the liquid is injected in two stages: a first, relatively low pressure stage to achieve mixing with the foamable ingredient without bursting the capsule, followed by a second, high pressure stage to open the outlet and release the contents into the receptacle. A pressure sensor or switch may be provided in the capsule water injection line to detect high water pressures in the capsule that could cause undesirably vigorous bursting of the capsule. Typically, the pressure sensor in the capsule injection line is set to detect a different pressure (e.g. about 0.7bar) indicative of capsule bursting risk than the pressure sensor in the nozzle line, which detects a pressure (e.g.1.2bar) indicative of nozzle blockage.

Preferably, the liquid is injected into the capsule containing the foamable material by a peristaltic, diaphragm or piston pump, preferably at an average rate of from about 250 to about 2000 ml/min and more preferably from about 500 to 1500 ml/min. The liquid may be injected in intermittent or pulsed fashion to optimise the amount of foam or the organoleptic properties of the product. Preferably, the method further comprises the step of injecting air into the capsule after injecting the liquid to expel residual liquid from the capsule.

In certain embodiments the total amount of liquid injected into the capsule containing the foamable material is from about 25 ml to about 100ml. For a hot foamed beverage the temperature of the liquid is typically from about 75 to about 100 degrees C.

The nozzle may be situated adjacent to the capsule containing the foamable material. Alternatively, the nozzle may be moved into the place of the capsule following ejection of the capsule from the beverage brewer.

In certain embodiments a single pump (such as a peristaltic, diaphragm or piston pump) is used to supply water to the capsule and to the nozzle. A valve (such as a solenoid-operated valve) may be provided to switch the flow of water between the capsule injector and the nozzle line for sequential mixing and jetting steps as described herein.

The method of the invention normally comprises the step of holding the capsule in a beverage brewer before the step of injecting liquid into the capsule. Preferably, the method further comprises the step of mechanical ejection of the capsule from the holder after the step of injecting liquid into the capsule. For example, the beverage brewer may comprise a waste bin into which the capsule is automatically and mechanically discarded. Preferably this takes place before or during the step of injecting further liquid.

The present invention is especially well suited for preparing foamed beverages in conjunction with known brewing steps in known vending machines. For example certain methods according to the invention further comprise the steps of: providing a second capsule containing a beverage brewing ingredient and having an outlet for allowing fluid to escape from the capsule; injecting water into the second capsule to brew a beverage inside the capsule; and allowing the beverage to escape through the outlet into the receptacle.

Preferably, the step of brewing a beverage is carried out after the steps of producing an edible foamed liquid, and the beverage escapes through the outlet into the edible foamed liquid in the receptacle. This enables drinks such as cappuccino to be made by brewing a coffee capsule immediately after the preparation of the foamy liquid in accordance with the invention, thereby avoiding the deleterious effect of coffee oils on the milk foaming.

In such methods the capsule containing a foamable ingredient and the second capsule containing a beverage brewing ingredient may be sequentially held in, and mechanically ejected from, the same capsule holder in the same brewing apparatus during the method.

Typically, the beverage brewing ingredient comprises ground coffee or leaf tea, preferably in an amount suitable to brew a single cup of beverage. For example, from about 2g to about 12g of ground coffee or from about 1g to about 9g of leaf tea. It will be appreciated that the construction of the capsule containing a beverage brewing ingredient will normally be substantially similar to the construction of the capsule containing a foamable food ingredient. It is a particular advantage of the present invention that the capsules can be manufactured and filled on the same equipment, and can be fed sequentially into the same capsule holding, brewing and manipulating mechanism. The beverage brewing capsule may additionally comprise a filter element, such as a filter paper bonded to an interior surface thereof.

The liquid may be injected into the capsule containing the beverage brewing ingredient in amounts, at pressures, and at temperatures similar to those described above in relation to the capsule containing the foamable ingredient.
In other embodiments the liquid is injected into the capsule containing the beverage brewing ingredient at pressures of from about 200 kPa to about 2 MPa (about 2 to about 20 bar), preferably from about 200 kPa to about 1 Mpa (about 2 to about 10 bar). These pressures are conventionally generated for brewing espresso coffee. Preferably, the liquid injected in this stage of the process consists essentially of water.

Preferably the total amount of liquid injected in the process according to the present invention is from 100 to 400 ml. Preferably the product comprises from about 10% to about 50% of foam by volume, more preferably from about 20% to about 35% foam by volume.

In certain embodiments the first pump may be used to supply liquid to both the capsule injector and to the liquid jet outlet. In other embodiments a second pump is provided for supplying liquid to the liquid jet . The liquid preferably consists essentially of water.

The beverage brewer preferably further comprises a mechanical ejection means for ejecting capsules from the holder after water injection is complete.
Preferably, the apparatus further comprises a mechanism operatively associated with the holder to retract the injection tube or tubes when the holder is opened.

In a third aspect the present invention provides a beverage brewing system comprising: a beverage making apparatus according to the present invention and comprising a capsule holder; a capsule containing a foamable ingredient and adapted to be received in the holder of the beverage brewer; and a second capsule containing a beverage brewing ingredient and also adapted to be received in the holder of the beverage brewer.

Preferably, the beverage brewing system is programmed to carry out the following steps in response to a signal to brew a foamed beverage: opening the capsule holder to receive the capsule containing a foamable ingredient; securing said capsule in the holder; followed by injecting liquid into the capsule containing the foamable ingredient; followed by ejecting the capsule from the holder; injecting a jet of liquid into the receptacle through the nozzle of the apparatus; opening the holder to receive the second capsule containing a beverage brewing ingredient; securing said capsule in the holder; followed by injecting liquid into the second capsule containing the beverage brewing ingredient to brew a beverage, and allowing the beverage to escape into the receptacle; followed by ejecting the capsule containing the beverage brewing ingredient from the holder.

As discussed above, the process may further comprise a final liquid injection through the nozzle to swirl and mix the beverage. The process may also comprise a final water spray over the beverage to "finish" the foam.

In certain embodiments the capsules used in the systems of the present invention may comprise machine readable pack recognition means on the capsule to assist use of the capsule in fully automated vending equipment. For example, the capsules may comprise machine readable projections or perforations or a bar code. In these embodiments the brewer comprises compatible machine recognition capabilities to recognise and manipulate the capsules.

Specific embodiments of the present invention will now be described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a longitudinal cross-section through a nozzle for a beverage making apparatus according to the invention;

Figure 2 shows a plan view of a capsule containing a foamable ingredient for use in a method according to the present invention;

Figure 3 shows a longitudinal sectional view through the capsule of Figure 2; and

Figure 4 shows a schematic view of the capsule of Figures 2 and 3 in the beverage making apparatus after injection of liquid into the capsule has been completed, and while further injection of a jet of liquid into a receptacle is taking place through the nozzle.

Referring to Figure 1, the nozzle is formed in one piece by injection molding of a thermoplastic such as a polyacetal, polypropylene or other food-approved plastic. The length of the nozzle is about 5 cm and the wall thickness is in the range 0.2 to 1.5 mm. The nozzle tapers from an inlet having an inside diameter of about 4mm to an outlet having a diameter of about 1mm. The bore of the nozzle is circular in cross-section tapered along its whole length with an included taper angle of about 2 degrees. The low taper angle results in a jet, rather than a spray, of water at the outlet. The inside surface of the bore is very smooth in order to minimise limescale deposition. The nozzle is provided with flanges to permit insertion and replacement of the nozzle in the apparatus using a spring-loaded bayonet fitting or similar.

Referring to Figures 2 and 3, the capsule 1 is in the form of a sachet formed from two sheets of laminated, metallised flexible plastic film 2,3 bonded together around a margin 4. A lower margin 5 of the sachet is bonded by means of a layer of adhesive 8 that can be released by the action of hot water inside the sachet. In a top margin of the sachet a nozzle 7 is inserted between the sheets 2,3 and bonded thereto in air tight fashion. The capsule has an internal volume of approximately 50cm^3 when fully distended. Thus far the construction of the package 1 is similar to the beverage brewing sachets described in EP-A-0179641 or WO99/05036. The capsule is approximately half filled with approximately 5-10g of a foamable powdered milk 6.

The nozzle 7 is formed by injection moulding of a thermoplastic material such as polypropylene. It is bonded by adhesive or melt bonding in air tight fashion to the front and back sheets 2, 3 of the sachet. The nozzle 7 comprises a bore region having an internal diameter of approximately 3mm, into which a water injection tube 15 is inserted in use. A flange is provided at the top of the nozzle to assist mechanical gripping and manipulation of the sachet in the brewing apparatus. Finally, a plastics laminated foil freshness barrier (not shown) is sealed over the top of the nozzle. This results in a fully air tight and moisture-tight package that is shelf stable.

With reference to Figure 4, in use the capsule 1 is held in a beverage brewer by capsule holder 11 which grips the capsule below the nozzle flange. A water inlet tube 15 is advanced to pierce the freshness barrier in the nozzle 7, and hot water at about 90°C is then injected through the tube 15 into the capsule 1. The hot water undergoes turbulent mixing with the powdered milk 6 in the capsule 1 to product an aqueous dispersion of the powdered milk. The hot water also releases the seal 8 at the bottom of the capsule, thereby allowing the aqueous milk dispersion to drop into the receptacle 17. The total amount of water injected in this stage is about 50 ml.

Once water injection into the capsule 1 is complete, the beverage brewer automatically jettisons the used capsule into a waste receptacle. Simultaneously

or sequentially, a jet of water 13 is pumped into the liquid mixture in the receptacle 17 through nozzle 12. The jet diameter is about 1 mm, the jet velocity is about 10 m/s and the amount of water injected through the jet is about 60 ml. The jet of water causes foaming of the mixture in the receptacle 17 to produce a foamed liquid comprising a liquid layer 18 and a foam layer 19.

The resulting foamed milky liquid requires the addition of a beverage flavour to render it more palatable. In accordance with the present invention a beverage brewing capsule is inserted into the same holder in the beverage brewer. The beverage brewing capsule is constructed in similar fashion to the capsule of Fig. 1, but is filled with ground coffee and incorporates a filter element. The beverage is brewed by injection of hot water into the nozzle of the capsule in similar fashion as for the milk-containing capsule. The brewed coffee escapes from the bottom of the capsule and drops through the foam layer 19 into the liquid layer 18 in the receptacle 17. A final jet of water may be briefly injected through nozzle 12 to swirl the contents of the receptacle 17 and thereby mix the brewed beverage with the milky liquid already in the receptacle. The spent beverage brewing sachet is then automatically discarded by the brewer.

The method according to the present invention may be carried out in either semi-automatic or fully-automatic fashion by beverage vending equipment. In the semi-automatic embodiment, the process is initiated by a user selecting a foamed beverage option from the vending equipment. The system signals the user to insert a milk powder capsule, for example by opening a door leading to a beverage brewing enclosure equipped with the capsule holder. The machine then automatically grips the capsule, and injects water into the capsule for a predetermined time to achieve the initial mixing and to deposit the water and milk powder mixture into the receptacle. The machine then automatically injects further water into the receptacle in a high velocity jet to achieve the desired hot foamed milk in the receptacle. The machine also automatically discards the spent capsule, either before or after the step of jetting. An advantage of discarding the capsule before the step of the jetting is that it allows the water jet nozzle to take the place of the capsule in the brewing cavity.

In the semi-automatic mode, the machine then signals to the user to insert a beverage brewing capsule. The user can select the desired beverage capsule, insert it into the same holder in the machine, whereupon the machine automatically injects water into the capsule to brew the beverage inside the capsule and to release the barrier at the bottom of the capsule to release the beverage into the receptacle. Finally, the machine automatically discards the spent brewing beverage capsule and "finishes" the foamed beverage by a brief water jet injection to swirl the beverage, and a brief water spray over the foam to remove any large bubbles on the surface of the foam.

In the fully automatic embodiments, the milk powder capsules and beverage brewing capsules are stocked inside the vending machine, and the machine additionally selects the appropriate sachets and feeds them to the sachet holder at the appropriate times in response to the initial beverage brewing instruction from the user.

The above embodiments have been described by way of example only. Many other embodiments falling within the scope of the accompanying claims will be apparent to the skilled reader.

CLAIMS

1. A beverage making apparatus, wherein the apparatus comprises a liquid injection nozzle having having an inlet and an outlet and a bore extending between the inlet and the outlet, wherein the cross-sectional area of the outlet is from about 0.2 to about 5 mm^2, and wherein the bore is tapered between the inlet to the outlet.

2. A beverage making apparatus according to claim 1, wherein the bore is substantially continuously tapered between the inlet of the nozzle and the outlet of the nozzle.

3. A beverage making apparatus according to any preceding claim, wherein the inner surfaces of the bore are substantially smooth.

4. A beverage making apparatus according to any preceding claim, wherein the angle of taper of the bore is in the range of from about 0° to about 10°.

5. A beverage making apparatus according to any preceding claim, wherein the angle of taper of the bore is in the range of from about 0.5° to about 5°.

6. A beverage making apparatus according to any preceding claim, wherein the length of the bore is in the range of from about 1cm to about 10cm.

7. A beverage making apparatus according to any preceding claim, wherein the cross-section of the bore is substantially circular.

8. A beverage making apparatus according to any preceding claim, wherein the apparatus further comprises a source of pressurised liquid connected to the inlet of the nozzle.

9. A process for the preparation of a beverage, wherein the process comprises the step of injecting a jet of liquid into a receptacle from a nozzle having

an inlet and an outlet and a bore extending between the inlet and the outlet, wherein the cross-sectional area of the outlet is from about 0.2 to about 5 mm^2, and wherein the bore is tapered between the inlet to the outlet.

10. A method according to claim 9, wherein the diameter of the jet is from about 0.7 to about 1.5 mm

11. A method according to claim 9 or 10, wherein the jet velocity of the liquid jet is from 5 to 50 m/s.

12. A method according to any one of claims 9 to 11, wherein the liquid is supplied to the nozzle at a pressure of from about 30 kPa (0.3 bar) to about 200 kPa (2 bar).

13. A method according to any one of claims 9 to 12, wherein the liquid is supplied to the nozzle at a temperature of from about 80 to about 100 degrees C.

14. A method according to any one of claims 9 to 13, wherein the jet is directed at an angle to the vertical to swirl the liquid in the receptacle.

15. A method according to any one of claims 9 to 14, wherein the bottom of the receptacle is located from 5 to 25cm below the bottom of the capsule outlet.

16 A method according to any one of claims 9 to 15, further comprising the step of applying a water spray to the top of the foamed liquid in the receptacle after said step of injecting a jet of liquid is completed.

17. A method according to any one of claims 9 to 16, wherein the receptacle contains a foamable ingredient and the liquid injected through the nozzle consists essentially of water.

18. A method according to claim 17 wherein the foamable ingredient comprises a partially or completely dehydrated dairy or non-dairy beverage whitener.

19. A method according to claim 17 or 18, wherein the dry weight of the foamable ingredient is from about 5 to about 50g.

20. A method according to claim 18 wherein the foamable ingredient comprises a dehydrated milk.

21. A method according to claim 17, comprising the steps of: providing a capsule containing a foamable ingredient and having an outlet for allowing fluid to escape from the capsule; positioning the receptacle to collect fluid escaping from the capsule through the outlet; injecting aqueous liquid into the capsule to mix with the foamable ingredient; allowing the foamable ingredient mixed with the aqueous liquid to escape through the outlet into the receptacle; followed by injecting a jet of further aqueous liquid into the receptacle through a the nozzle to produce a foamed liquid in the receptacle.

22. A method according to claim 21, further comprising the step of gripping the capsule in a holder before the step of injecting water into the capsule.

23. A method according to claim 22, further comprising the step of mechanical ejection of the capsule from the holder after the step of injecting water into the capsule and before the step of injecting further water.

24. A method according to claim 21, 22 or 23, further comprising the steps of:

providing a second capsule containing a beverage brewing ingredient and having an outlet for allowing fluid to escape from the capsule;

injecting liquid into the second capsule to brew a beverage inside the capsule; and

allowing the beverage to escape through the outlet into the receptacle.

25. A method according to claim 23, wherein the said steps of injecting liquid into the second capsule is carried out after the steps of producing an edible foamed liquid, and the beverage is added to the edible foamed liquid in the receptacle.

26. A method according to claim 24 or 25, wherein the capsule containing a foamable food ingredient and the second capsule containing a beverage brewing ingredient are sequentially held in, and mechanically ejected from, the same holder during said method.

27. A method according to claim 24, 25, or 26, wherein the beverage brewing ingredient comprises ground coffee or leaf tea.

28. A beverage brewing system comprising:

a beverage making apparatus according to claim 1 and having a holder for holding a capsule;

a capsule containing a foamable ingredient and adapted to be received in the holder of the beverage brewer; and

a second capsule containing a beverage brewing ingredient and adapted to be received in the holder of the beverage brewer.

29. A beverage brewing system according to claim 28, when programmed to carry out the following steps in response to a signal to brew a foamed beverage:

opening the holder to receive the capsule containing a foamable food ingredient; securing said capsule in the holder; followed by

injecting liquid into the capsule containing a foamable ingredient;

ejecting the capsule from the holder

injecting liquid into the receptacle in a jet having a diameter of from about 0.5 to about 2 mm;

opening the clamp to receive the capsule containing a beverage brewing ingredient; securing the second capsule in the holder; followed by

injecting liquid into the second capsule containing the beverage brewing ingredient; followed by

ejecting the capsule containing the beverage brewing ingredient from the clamp.

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Application No: GB 0122515.0 **Examiner:** Jason Scott
Claims searched: 1-29 **Date of search:** 27 February 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B2F (FED); A4E

Int Cl (Ed.7): A47J; B65D

Other: ONLINE: WPI, JAPIO, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0801922 A1	QUICK ITALIA S R L See whole document and in particular column 1, lines 49-54	
X	FR 2513106 A	BOSCH SIEMENS HAUSGERAETE See whole document and in particular page 1, paragraph 4.	1, 3, 7-10 & 13
A	GB 2121762 A	MARS See whole document	

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